Annex 22. A. GHG calculation methodology BioClima (See annex 22.B.)

The calculation methodology of the GHG emission reduction was developed considering different source of information, assumptions and specific formulas taking into consideration BIOCLIMA's components and characteristic..

A. Scope of the carbon accounting considering BIOCLIMA's components

Project Component	Scope of carbon accounting	
Component I. Conserving and producing for life		
1.1. Landscape restoration, forest conservation and climate-resilient production	**Carbon removal**	**Avoided emissions**
A. Degraded pasture- and rangeland restored (production models)		
1. Agroforestry - cocoa	Carbon sequestered by the implementation of Cocoa-agroforestry systems in areas directly impacted by the project is accounted. The total areas are multiplied by the incremental removal factor considered for these types of systems.	Areas indirectly benefited by the project interventions at the farm level are counted. In other words, it is assumed that as a result of the implementation of the cocoa-agroforestry systems deforestation will be reduced in other areas of the producer's farm. It means less GHG emission
2. Silvopasture	Carbon sequestered by the improvement of livestock activity with the implementation of silvopastoral systems in areas directly impacted by the project is accounted. These areas are multiplied by the incremental removal factor considered for these types of systems.	Areas indirectly benefited by the project interventions at farm level are counted. In other words, it is assumed that as a result of the improvement of silvopastural systems deforestation will be reduced in other areas of the producer's farm.. It means less GHG emission

3. Multifuncional Planted Forest	Carbon sequestered as results of increase of forest biomass with natural regeneration and enrichment in areas directly impacted by the project is accounted. These areas are multiplied by the removal factor considered for these types of systems.	Areas indirectly benefited by the project interventions at farm level are counted. In other words, it is assumed that as a result of the project's actions at the farm level deforestion will be reduced. . It means less GHG emission
B. Natural forest ecosystems and forest land conserved, restored and sustainably used (Production model)		
1. Sustainable community enterprises	Carbon sequestered as result of the direct impact of the sustainable forest management is counted. The total area is multiplied by the removal factor considered for sustainable forest management	Areas directly benefited by the project intervention are counted. In other words, it is assumed that as a result of the project's actions deforestation in the project's intervention zones will be reduced. . It means less GHG emission
2. Community-based forest management	Carbon sequestered as result of the direct impact of the sustainable forest management is counted. The total area is multiplied by the removal factor considered for these types of forest management.	Areas directly benefited by the project intervention are counted. In other words, it is assumed that as a result of the project's actions deforestation will be reduced. . It means less GHG emission
2.1Finance commercial Community Forest Management (CFM)		
2.2 Finance commercial Community Forest Restoration (CFR)		
Component II. Good governance/Component 3. Capacity development for productive landscape restauration and forest conservation		
Improved governance of forest areas indirectly impacted by BIOCLIMA's territorial investments		

4. Forest areas for sustainable community enterprises	Areas indirectly benefited by the project's intervention to improve the forest governance are counted. In other words, it is assumed that as a result of the project's actions, the forest areas are preserved to remove higher level of carbon. The total area is multiplied by the removal factor considered for forest zones	Areas indirectly benefited by the project's interventions related with forest governance are counted. In other words, it is assumed that as a result of the project actions deforestation will be reduced in areas that are not directly under the project impact (Potential area). It means less GHG emissions The total area is multiplied by the removal factor considered for forest zones
5. Forest areas for community-based forest management	Areas indirectly benefited by the project's interventions to improve the forest governance are counted. In other words, it is assumed that as a result of the project's actions, the forests are managed appropriately to improve the carbon removal. The total area is multiplied by the removal factor considered for forest zones	Areas indirectly benefited by the project's interventions related with forest governance are counted. In other words, it is assumed that as a result of the project actions, deforestation will be reduced in forest areas that are not directly under the project investments (Potential area). It means less GHG emissions. The total area is multiplied by the removal factor considered for forest zones

B. Calculation formula for carbon accounting

Project Component	**Calculation formula for carbon accounting**	
Component I. Conserving and producing for life		
1.1. Landscape restoration, forest conservation and climate-resilient production	**Carbon Removal**	**Avoided emissions**
A. Degraded pasture- and rangeland restored (production models)		
1. Agroforestry - cocoa	(carbon sequestration factor, with project situation -carbon sequestration factor, without project situation (grassland-traditional silvopasture	(Indirect beneficiary area (ha)-direct beneficiary area(ha))*emission reduction target (%)*annual deforestacion rate for perennial crop

	system)*Benefited area (has) of agroforestry system)	(%)*% of forest area in the farm*emission factor for deforestation
2. Silvopasture	(carbon sequestration factor, with project situation - carbon sequestration factor, without project situation) *Benefited area (has) of silvopatural systems) + avoided methane emmisions livestock activity	(Indirect beneficiary area (ha)-direct beneficiary area(ha))*emission reduction target (%)*annual deforestacion rate for livestock activity (%)*% of forest area in the farm*emission factor for deforestation
3. Multifuncional Planted Forest	(carbon sequestration factor, with project situation - carbon sequestration factor, without project situation) *Benefited area (has) of silvopatural systems)	(Indirect beneficiary area (ha)-direct beneficiary area(ha))*emission reduction target (%)*annual deforestacion rate in tacol areas (%)*% of forest area in the farm*emission factor for deforestation
B. Natural forest ecosystems and forest land conserved, restored and sustainably used (Production model)		
1. Sustainable community enterprises	(carbon sequestration factor, with project situation - carbon sequestration factor, without project situation) *Benefited area (has) of sustainable forest management	(direct beneficiary area(ha))*emission reduction target (%)*annual deforestacion rate in forest areas(%)*emission factor for deforestation)
2. Community-based forest management	(carbon sequestration factor, with project situation - carbon sequestration factor, without project situation) *Benefited area (has) of community forestry management	(direct beneficiary area(ha))*emission reduction target (%)*annual deforestacion rate in forest areas(%)*emission factor for deforestation)
2.1Finance commercial Community Forest Management (CFM)		
2.2 Finance commercial Community Forest Restoration (CFR)		
Component II. Good governance/Component 3. Capacity development for productive landscape restauration and forest conservation		
Improved governance of forest areas indirectly impacted by BIOCLIMA's territorial investments		

4. Forest areas for sustainable community enterprises	(carbon sequestration factor, with project situation - carbon sequestration factor, without project situation)*indirect beneficiary area(ha) for improved governance of forest areas	(Indirect beneficiary area (ha))*emission reduction target (%)*annual deforestation rate in forest areas (%)*emission factor for deforestation
5. Forest areas for community-based forest management	(carbon sequestration factor, with project situation - carbon sequestration factor, without project situation)*indirect beneficiary area(ha) for improved governance of forest areas	(Indirect beneficiary area (ha))*emission reduction target (%)*annual deforestation rate in forest areas (%)*emission factor for deforestation

C. Assumptions for estimating avoided emission

C.1 General Assumptions

Parameters	Value	Source	Note
Conversion factor from C to C02 eq.	3.67	Standard	
Percentage of producers' farms with forest area (beneficiaries' cocoa model)	10%	Assumption	
Percentage of producers' farms with forest area (beneficiaries' silvopasture model)	10%	Assumption	
Percentage of producers' farms with forest area (beneficiaries' FMP model)	10%	Assumption	
Annual deforestation of areas with potential for community forest management	1.30%	Forest Carbon Partnership Facility (FCPF) - Caribbean Coast Emission Reduction Program (ERPD) - Nicaragua (MARENA)	The ERPD is the principal component of Nicaragua´s national ENDE-REDD+ framework. In this sense, the formulation of this proposal used official
Annual deforestation in forest area with conservation potential	1.40%	Forest Carbon Partnership Facility (FCPF) - Caribbean Coast Emission Reduction Program (ERPD) - Nicaragua (MARENA)	

Annual deforestation for livestock activity	3.26%	Forest Carbon Partnership Facility (FCPF) - Caribbean Coast Emission Reduction Program (ERPD) - Nicaragua (MARENA)	emission factors which has been considered in the Nicaragua's third national communication
Annual deforestation for production of perennial crops (cocoa, coffee, etc.)	3.26%	Forest Carbon Partnership Facility (FCPF) - Caribbean Coast Emission Reduction Program (ERPD) - Nicaragua (MARENA)	
Annual degradation of tacotales/shrub areas/herbaceous/sharp slopes	3.26%	Assumption	
Average emissions from deforestation of forest area(tC02/ha)	147	Forest Carbon Partnership Facility (FCPF) - Caribbean Coast Emission Reduction Program (ERPD) - Nicaragua (MARENA)	
Average emissions from tacol degradation (tC02/ha)	147	Assumption	
Conversion from tC02 to MtC02	1000000	Standard	
Emission reduction target	50%	Forest Carbon Partnership Facility (FCPF) - Caribbean Coast Emission Reduction Program (ERPD) - Nicaragua (MARENA)	
Leakages		Bio-CLIMA will intervene in Caribbean Region of Nicaragua in the all those areas that are still covered with forests (see Map 1 of FP). There are not other big forest areas left in the CR, nor in Nicaragua, where deforestation could increase as a result of Project interventions, therefore the risk of leakage is deemed to be minor.	

C.2 Emission factors for estimating avoided emissions

	Avoided emission for deforestation - without project	Avoided emission for deforestation - with project situation	Source
	tC02/ha	tC02/ha	Forest Carbon Partnership Facility (FCPF) - Caribbean Coast Emission Reduction Program (ERPD) - Nicaragua (MARENA)
A. Degraded pasture- and rangeland restored (production models)			
1. Agroforestry - cocoa	***n.a***	***147***	
2. Silvopasture	***n.a***	***147***	
3. Multifuncional Planted Forest	***n.a***	***147***	
B. Natural forest ecosystems and forest land conserved, restored and sustainably used (Production model)			
4. Sustainable community enterprises	***n.a***	***147***	
C. Community-based forest management	***n.a***	***147***	

D. Emission factors for estimating carbon removal

	Without project situation	With project situation	Source	Note
	tC02/ha/yr	tC02/ha/yr		
Component I. Conserving and producing for life				
1.1. Landscape restoration, forest conservation and climate-resilient production				

A. Degraded pasture- and rangeland restored (production models)				
1. Agroforestry - cocoa	***6.5***	***11.2***	Forest Carbon Partnership Facility (FCPF) - Caribbean Coast Emission Reduction Program (ERPD) - Nicaragua (MARENA)	The ERPD is the principal component of Nicaragua´s national ENDE-REDD+ framework. In this sense, the formulation of this proposal used official emission factors which has been considered in the Nicaragua's third national communication
2. Silvopasture	***2.1***	***6.0***	Forest Carbon Partnership Facility (FCPF) - Caribbean Coast Emission Reduction Program (ERPD) - Nicaragua (MARENA)	
3. Multifuncional Planted Forest	***6.0***	***25.3***	Forest Carbon Partnership Facility (FCPF) - Caribbean Coast Emission Reduction Program (ERPD) - Nicaragua (MARENA)	
B. Natural forest ecosystems and forest land conserved, restored and sustainably used (Production model)				
1. Sustainable community enterprises	***20.0***	***23.6***	Forest Carbon Partnership Facility (FCPF) - Caribbean Coast Emission Reduction Program (ERPD) - Nicaragua (MARENA)	
2. Community-based forest management			Forest Carbon Partnership Facility (FCPF) - Caribbean Coast Emission Reduction Program (ERPD) - Nicaragua (MARENA)	
2.1Finance commercial Community Forest Management (CFM)	***22.5***	***26.5***	Forest Carbon Partnership Facility (FCPF) - Caribbean Coast Emission Reduction Program (ERPD) - Nicaragua (MARENA)	

2.2 Finance commercial Community Forest Restoration (CFR)	***22.5***	***26.5***	Forest Carbon Partnership Facility (FCPF) - Caribbean Coast Emission Reduction Program (ERPD) - Nicaragua (MARENA)	

E. Assumptions for estimating GHG emission reduction in the livestock activities

Parameters	Value	Source	Note
Producer's average herd size	42	CIAT, feasibility study	
Days (year)	365	Standard value	
Conversion from kg to tonnes	1000	Standard value	
Conversion from methane to C02 eq	21	The Global Warming Potential (GWP100) AR5 IPCC report (https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter08_FINAL.pdf 2014, Table 8.7)	From the Tercera Comunicación Nacional de Cambio Climático – Nicaragua (http://www.cambioclimatico.ineter.gob.ni/Tercera%20Comunicaci%C3%B3n%20Nicaragua.pdf) is still using GWP of 21.
Conversion from nitrite to C02 eq	310	The Global Warming Potential (GWP100) AR5 IPCC report (https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter08_FINAL.pdf 2014, Table 8.7)	From the Tercera Comunicación Nacional de Cambio Climático – Nicaragua (http://www.cambioclimatico.ineter.gob.ni/Tercera%20Comunicaci%C3%B3n%20Nicaragua.pdf) is still using GWP of 21.
Animal unit per hectare/before project (AU/ha)	1.26	CIAT, feasibility study	
Animal unit per hectare/after project (AU/ha)	3.17	CIAT, feasibility study	

F. Emission factors for estimating the livestock activity

Greenhouse gases	Emissions tCO2 eq/animal/year		Source
	Traditional system (without project situation)	Improved system (with project situation)	
Methane enteric fermentation	2.498	1.821	FAO GLEAM model specifically customized to Nicaragua considering the livestock systems in Bosawas and Indio Maiz
Methane manure management	0.055	0.044	
Nitrous oxide manure management	0.097	0.077	
Nitrous oxide from feed	0.780	0.057	

G. Calculation formula for estimating GHG emission reduction of the livestock activity

Calculation formula
(With project situation: (Emission factor at tCO2 eq/year, methane enteric fermentation)*Producer's average herd size+(Emission factor at tCO2 eq/year, Methane manure management)+(Emission factor at tCO2 eq/year, Nitrous oxide manure management)*Producer's average herd size+(Emission factor at tCO2 eq/year, Nitrous oxide from feed)*Producer's average herd size)) - (Without project situation: (With project situation: (Emission factor at tCO2 eq/year, methane enteric fermentation)*Producer's average herd size+(Emission factor at tCO2 eq/year, Methane manure management)+(Emission factor at tCO2 eq/year, Nitrous oxide manure management)*Producer's average herd size+(Emission factor at tCO2 eq/year, Nitrous oxide from feed)*Producer's average herd size)

H. Summary: Aggregated calculation methodology

Componente/Activity	Current situation	Area ha	Without project	With project	Quantification/ Assumptions	Reference
Component 1: Investments in landscape restoration; conservation & sustainable forest management, climate resilient productive systems	High level of deforestation and land degradation	603,035	Less sustainable productive practices will be continued and cause deforestation and land degradation.	The project will support 3 sets of interventions/investments:	a) Calculations were done considering with project situation vs. without project situation b) The investments will generate direct and indirect GHG impact: i) implementation of productive models and ii) improvement in forest governance	Forest Carbon Partnership Facility (FCPF) - Caribbean Coast Emission Reduction Program (ERPD) - Nicaragua (MARENA)

			Total 61,209 ha	1) landscape restoration in degraded lands through Sustainable silvopastoril systems (12,144) Cacao agroforestry systems (8,850 ha) Planted Multifunctional forest (40,215 ha)	**Main Assumptions:** i) Direct impacts in areas of intervention of the project from sequestered CO2 absorptions from AGB and BGB resulting from improvements in biomass production from conservation and sustainable forest management ii) The indirect impacts from avoided GHG emissions will be generated from prevention of deforestation in the intervention areas due to improvements in production systems. This is set to 10% of forested areas in the cacao, silvopastoril and PMF production systems. iii) Annual deforestation rates are based on the assumption used by the ERPD mechanism and are estimated to be: 1.30 % community forest; 1.40 % conservation forest; 3.26% deforestation for activities related to livestock mgmt/agriculture. Degradation rate of shrublands are estimated at 3.26% as well. **Captured carbon** i) For Cacao Agroforestry Total intervention Area * emission factor ii) For silvopastoril Total intervention Area * (emission factor with project – emission factor without project) + (livestock emissions with project – livestock emissions without project) **iii) For PMF** Total intervention Area * (emission factor with project – emission factor without project **Avoided deforestation:** Non-intervention area (ha)*proposed reduction in deforestation by the project (%)*deforestation annual rate*% in forest cover*emission factor* reduction emission target	The emission factors used are: Silvopastoril without project 2.1 $CO_{2\ eq}$ /ha/año With Project 6 t $CO_{2\ eq}$ /ha/año Cacao agroforestal Without project: 6.5 eq/ha/año With Project: 11.2 tCO2 eq/ha/año MFS Without project 6 tCO2 eq/ha/año With project 25.3 tCO2 eq/ha/año Deforestation emission factor: 147 eq/ha Degradation emission factor: 147 eq/ha MFS

			332,033 has	2) Conservation and sustainable forest management	**For CO2eq capture:** Total intervention Area * emission factor **Avoided deforestation** Intervention area (ha)*proposed reduction in deforestation by the project (%)*deforestation annual rate*% in forest cover*emission factor	The emission factor used is: Without project 20. CO2 eq /ha/año With Project 23.6 t CO2 eq /ha/año Deforestation emission factor: 147 eq/ha
			209,793 ha	3) Community Forest Management	**For CO2eq capture:** Total intervention Area * emission factor **Avoided Deforestation** Intervention area (ha)*proposed reduction in deforestation by the project (%)*deforestation annual rate*% in forest cover*emission factor	The emission factor used are: without project 22.5 CO2 eq /ha/año With Project 26.5 t CO2 eq /ha Deforestation emission factor: 147 eq/ha
Component 2 & 3: Governance and institutional strengthening	Limited oversight and governance	1,716,325	Deforestation due to illegal cuttings will continue	Strengthen institutions to implement the national forest legislation. Reduce deforestation and land degradation as a result	**Avoided deforestation:** Intervention area (ha)*proposed reduction in deforestation by the project (%)*deforestation annual rate*% in forest cover*emission factor	Forest Carbon Partnership Facility (FCPF) - Caribbean Coast Emission Reduction Program (ERPD) - Nicaragua (MARENA) Deforestation emission factor: 147 eq/ha